DOCUMENT RESUME

ED 277 366 IR 012 475

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TITLE Implementation of a District Computerized Instructional Management System: Barriers and Facilitators.
INSTITUTION Far West Lab. for Educational Research and Development, San Francisco, Calif.
SPONS AGENCY National Inst. of Education (ED), Washington, DC.
PUB DATE Apr 86
CONTRACT 400-83-0003
NOTE 40p.; Paper presented at the Annual Meeting of the American Educational Research Association (67th, San Francisco, CA, April 16-20, 1986). For another report on this project, see IR 012 476.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Adoption (Ideas); *Computer Assisted Testing; *Computer Managed Instruction; Educational Objectives; Elementary Education; *Mathematics Achievement; Pilot Projects; Program Evaluation; *Program Implementation; School Surveys; Success
IDENTIFIERS Far West Laboratory for Educational R and D CA

ABSTRACT

A two-part research and evaluation study was conducted to examine an elementary (K-8) school district's implementation of a computerized instructional management system, the "Computer-Managed Instruction/3000" (CMI), as a means of facilitating the assessment and updating of student mastery of 78 district-defined curricular objectives. The testing system consisted of a data bank of tests based on the district mathematics objectives, equipment to machine score student answer sheets, and reports detailing student mastery of the objectives. This system was piloted by administrators and teachers at four district-selected schools. A detailed interview schedule was developed to elicit such information as background in the district; knowledge of the CMI system, including how, why, and by whom it was selected; uses of the system for testing and instruction; technical problems; potential uses of the system; and its effects on school organization and instruction. Analysis of the responses of 49 school staff members--principals, resource teachers, teachers, and clerical staff from both pilot and nonpilot schools--identified a number of factors as keys to the implementation of the program: (1) planning; (2) communication and awareness of its purpose; (3) support from key personnel; (4) training; (5) technical issues and procedures; and (6) rewards and incentives for using the system. When viewed positively, these factors operated as facilitators to the acceptance and implementation of the system; however, when viewed negatively, the same factors operated as barriers. Data summaries are provided in Tables 1-7. The Study Interview Schedule and the Coding Matrix are appended, and references are provided. (DJR)

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IMPLEMENTATION OF A DISTRICT COMPUTERIZED INSTRUCTIONAL MANAGEMENT SYSTEM: BARRIERS AND FACILITATORS

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Paper Presented at the Annual Meeting of
The American Educational Research Association

San Francisco, California
April, 1986

This work was supported by a contract from the National Institute of Education, Department of Education, under Contract No. 400-83-0003. The contents of this report do not necessarily reflect the views or policies of the Department of Education or the National Institute of Education.

IR012475

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Implementation of a District Computerized Instructional Management System: Barriers and Facilitators

This report presents results of a research and evaluation study conducted by the Far West Laboratory, in cooperation with an elementary (grades K-8) school district. The study examined the district's implementation of a computerized instructional management system. The "Computer Managed Instruction/3000" system was selected by the district as a means to facilitate the assessment and updating of student mastery of 78 district-defined curricular objectives. The testing system consisted of a data bank of tests which were based on the district mathematics objectives, equipment to machine score student answer sheets, and reports detailing student mastery of the objectives. The system was piloted by administrators and teachers at four district-selected schools. The objective of this paper is to discuss the barriers and facilitators which were encountered during the pilot implementation of the CMI testing system from January to June, 1985.

This project emerged from a previous study conducted by the Instructional Management Program at the Far West Laboratory for Educational Research and Development (FWLERD), a regional survey of instructional management practices in school districts located in the Laboratory's tri-state region (Northern California, Nevada, and Utah). Educators reported computerized instructional management systems as "exemplary" practices for instructional improvement (Rowan, Edelstein, & Leal, 1985). However, the survey also elicited concerns about problems of implementing district-level instructional management systems. Examples of such concerns included lack of training of system users, lack of assessment, difficulty in adapting systems to the needs of instructional decisionmakers, and fears of evaluation by teachers (Rowan, 1984; Rowan et al., 1985).

Perspectives

Concrete guidelines for designing instructional management systems have been provided by the literature on criterion-referenced testing (Linn, Madaus, & Padulla, 1982), curriculum alignment (Milazzo, Buchanan, & Schutz, 1981), mastery learning (Block, 1971; Bloom, 1976), and outcome-based education (Spady, 1982). However, less attention has been paid to problems and guidelines for implementing such systems (Filby, 1984).

Studies of change and implementation of innovations in schools and districts have shown that success of implementation, including district-wide administrative computing systems, depends upon many factors (Brown, 1984). One important factor is the support of the principal and other key personnel such as resource teachers (Brown, 1984).

Roberts (1978, as reported by Brown, 1984) identified potential facilitators and barriers to change; especially crucial to our analysis of the implementation of the computerized instructional management system are the key strategic factors of planning, support, and training, as well as

the key process factors of participation, communication, and motivation. This framework was useful in our analysis.

CMI and District Background

Oak Knoll Elementary School District (a pseudonym), a medium-sized district with 18 elementary and 6 middle schools, instituted a district curriculum based on CTBS-correlated performance objectives in 1983. The district adopted a plan requiring teachers to update their students' progress periodically on the 78 district objectives. Teachers had been updating with a "matrix" on which they recorded mastery, partial mastery or nonmastery for the objectives required for their grade level and subject(s). Some teachers had used their own tests for updating, while others used their judgment on their students' progress. The CMI system fit into this larger district instructional management program by providing a systematic and standardized means for teachers to accomplish the task of updating.

In 1984 the district purchased "Computer Managed Instruction/3000" (CMI), a software package for the HP 3000 computer. The CMI system was designed by a school district in another state. Using its own objectives, Oak Knoll Elementary School District (OKESD) constructed criterion-referenced tests (CRT's) correlated with CTBS objectives. The CMI can generate and machine score CRT's; update student records for mastery of district objectives while scoring student tests; generate reports on mastery of objectives with information on individual students, classes or grade levels within schools and across schools in the district; correlate objectives with instructional materials and strategies; and allow teachers to input their own tests into a test data bank.

The CMI pilot implementation program was initially planned to start at the beginning of the 1984-85 academic year. However, this schedule was delayed due to problems in securing the necessary hardware. By the middle of the school year, hardware (consisting of a computer terminal, test scanner, modem, and phone lines) was installed in four pilot schools designated by the district to implement the testing system. While other schools had access to the tests, only some chose to use them with scanning equipment located at the district office. During the span of our study, the district utilized the CMI feature of district-developed CRT's in mathematics, and we thus focused on studying CMI use in mathematics. CRT's for reading and language arts were also being developed, but had only begun to be implemented by the end of the school year.

Method

Data Sources

One source of information was a Study Group formed of OKESD personnel. These district office and school staff (including principals, resource teachers, teachers and clericals) met periodically with FWLERD project staff from January through October, 1985. The Study Group described the climate and history of the district, identified directions for inquiry,

and represented a variety of perspectives and attitudes within the district.

A detailed interview schedule was developed to elicit such information as background in the district; knowledge of the CMI system regarding how, why, and by whom it was selected; uses of the system for testing and instruction; technical problems; potential uses of the system; and effects of the system on school organization and instruction (see Appendix). Responses to the interviews served as the data sources for this study. [A second interview schedule was devised for district office personnel to capture more detailed information concerning CMI-related decision making, planning, coordination, and communication at the district level, but the analysis of those interviews appears elsewhere (Crist-Whitzel, Edelstein, & Terry, 1985).]

Sample

Sixty staff members from throughout the Oak Knoll District were interviewed. Through a process of nomination by district and school site staff, 49 administrative and teaching personnel from four district-designated pilot schools and four similar schools not implementing the CMI were selected for our school-level sample. There was an attempt to balance the sample with both users and nonusers, as well as to include respondents with both positive and negative attitudes toward the system. Interviews lasting approximately one to two hours were held from March through June, 1985 with 26 respondents from the four pilot sites (four principals, six resource teachers, 13 teachers, and three aides) and 23 respondents from nonpilot schools (four principals, four resource teachers, and 15 teachers). The sample is depicted in Table 1. [To obtain district-level perspectives for a separate analysis, 11 staff members from the district's central office were also selected for our sample.]

Data Analysis

Interviews were transcribed, and written summaries were prepared by the interviewers from audiotapes and handwritten notes taken during the interviews. Analysis of the interviews consisted of both qualitative and quantitative methods. A coding scheme, devised to correspond to the interview schedule and the range of responses to the interview questions, was used to generate frequency counts and to construct a general picture of response patterns that illustrated various aspects of CMI use (see Appendix for the coding scheme). At the same time, a qualitative analysis of the interview protocols provided descriptive data including illustrative quotations and examples to provide more contextual detail. Both types of analysis were used in examining our data to identify factors that seemed to operate as either barriers or facilitators to the CMI implementation.

Table 1
Interview Sample Description

Position	Pilot Schools	Nonpilot Schools	Totals
Principals	4	4	8
Resource Teachers	5	3	8
Teachers	14	16	30
Clerical/Aides	3	—	3
Total for Schools	26	23	49
District Office Personnel			11
Total Sample			60

Results

In examining the data gathered during interviews with personnel in the Oak Knoll Elementary School District, a number of factors emerged as key to the implementation of the Computer Managed Instruction/3000 program, which was designed to run on the district's HP3000. When viewed as positive by staff members, these factors operated as facilitators to the acceptance and implementation of the CMI system. On the other hand, when viewed as negative aspects of the CMI by Oak Knoll personnel, these factors tended to serve as barriers to the successful implementation of the system.

In this section we briefly discuss the major sources of resistance (barriers) and factors that facilitated the implementation of the CMI, using the organizing themes of: (1) planning, (2) communication and awareness of its purpose, (3) support from key personnel, (4) training, (5) technical issues and procedures, and (6) rewards and incentives for using the system. The sources of these data are the interviews with 49 school personnel in the Oak Knoll School District including principals, resource teachers, teachers and clericals from both pilot and nonpilot schools (see Table 1). This section focuses on overall responses from the four pilot and the four nonpilot schools.

Planning

Although the majority of both pilot and nonpilot personnel had positive attitudes toward the CMI (see Table 2), a number of personnel from all levels seemed to resist the CMI idea, some citing lack of school level input as an explanation for their attitudes. Several Oak Knoll staff members who stated that the CMI plan was a "top-down" decision made by the board with minimal consultation from potential users, with its use mandated at the school level. Further it was the opinion of 10% of the respondents (see Table 3) that there was no input from any teachers or the teachers' association in the last-minute decision to use the CMI system designed by another school district. One staff member claimed the primary concern of the CMI implementation was the needs of the district administration; the needs of the classroom teacher were not appropriately considered. A number of staff believed they had ideas that could be helpful in the development, implementation and effective use of the system. For example, an administrator mentioned that the expertise of mentor teachers could have been useful in developing the CMI tests. Teachers were later instrumental in developing CMI tests for reading.

Poor planning was another frequently-mentioned CMI problem. The late implementation of the CMI was cited as an example of this. It was reported that CMI service, which was to have begun in the fall, did not actually begin until the spring. Phone lines and computer hardware were not in place until that time. Interviewees (20%) felt that this was too late in the year for implementation (see Table 3) as it interfered with other district and classroom activities, such as spring CTBS testing.

Table 2
Attitude Towards the CMI
Indicated by Pilot and Nonpilot Respondents

	Percentage of Respondents		
	(n=26) Pilot	(n=23) Nonpilot	(N=49) Total
Positive	58	52	55
Negative	12	9	10
Uncertain	27	35	31
Unknown	3	4	4

Table 3
Sources of Resistance
Indicated by Pilot and Nonpilot Respondents

	Percentage of Respondents		
	(n=26) Pilot	(n=23) Nonpilot	(N=49) Total
Too much/too rapid change	24	34	28
Doubt about district commitment	8	22	14
Too late in year for implementation	27	13	20
Technical problems	65	9	39
Lack of support from respected teachers	8	0	4
Lack of support from teachers' association	8	0	4
Lack of support from principal	12	13	12
Lack of support from district	12	22	16
Processing/reporting too slow	35	17	26
Problems with reports/data	31	13	22
Fear of evaluation	16	35	24
Inadequate training	35	22	28
Too much paperwork	15	30	22
Too much class time	19	17	18
A lot/too much time	31	26	28
Coercion - mandated by district	8	9	8
Lack of confidence in tests	23	9	16
Teachers not asked for input	12	9	10
Coordination and supply of materials	19	13	16
Other	31	34	33

This response was more evident among pilot school respondents (27%) than nonpilot respondents (13%), as they were the group with the heaviest involvement in implementation.

Another problem cited was "the lack of clear-cut short-term and long-term goals," which resulted in poor communication and contradictory information being provided to schools. Some district personnel (28%) felt that too many new programs had been introduced in a comparatively short period of time. Nonpilot respondents were somewhat more inclined to propose such a reservation about the implementation of the CMI than pilot respondents (34% versus 24%). Along with CMI last year, there were new programs in reading, language, social studies and spelling; there were school plans to be implemented, and state-mandated evaluation of schools. Due to other academic demands, a number of teachers were reluctant to embrace new commitments. One teacher said, "I don't have the time to incorporate new tests into my instruction."

Communications and Awareness

To develop awareness of the CMI, clear communication to staff at the school level is needed. Widespread knowledge about the CMI and its purpose should facilitate its acceptance and use in schools.

We found that the existence and purpose of the CMI system were not well known in the district. In fact, several Study Group members and staff members being interviewed asked for information about the CMI because they had not been aware of its existence and/or its purpose.

We found that perceptions of the purpose of the CMI system varied from instructional to non-instructional uses. The instructional uses that were mentioned included the role of the system in focusing the content of instruction on the terminal objectives. The non-instructional uses cited were monitoring student progress and updating mastery; assessment of mastery and testing as related to the CMI; evaluating teacher performance; increasing test scores; standardizing district measures of mastery.

While some interviewees mentioned only one purpose, others mentioned several of the six general categories of purposes (see Table 4). The rate at which each purpose was mentioned tended to be consistent across both pilot and nonpilot schools:

- monitoring student progress including the updating of the mastery of terminal objectives (51%)
- testing students in order to assess their mastery of the curriculum objectives, and how this correlates with the CTBS test (51%)
- standardizing the district measures of mastery (41%)
- focusing instruction and the content of the curriculum on the 78 terminal objectives (33%)
- evaluating teachers and their performance (10%)

Table 4
Purposes of the CMI
Reported by Pilot and Nonpilot Respondents

	Percentage of Respondents		
	(n=26) Pilot	(n=23) Nonpilot	(N=49) Total
Monitoring	46	57	51
Curriculum	31	35	33
Testing	58	43	51
Evaluation	12	9	10
Increasing Test Scores	8	4	6
Standardization	38	43	41

- increasing student test scores on the CTBS through practice with CMI tests (6%)

The perceived purposes of the CMI can serve as either barriers or facilitators to its implementation. Twenty-four percent of the school staff who were interviewed perceived the CMI testing system as an evaluative tool, which was a source of resistance for some (see Table 3). In nonpilot schools, 35% of the personnel interviewed felt that the CMI had the negative potential of being used to evaluate teachers, a perception of its purpose which thus posed a barrier. On the positive side, principals and teachers alike reported that frequency of testing and results from updating could be used as a measure of effective teaching. This perception could be a facilitator to the implementation process. When looking at these figures for teachers only, we observed that some teachers perceived the use of the CMI testing system for administrative purposes as a positive measure or facilitator (20%), while other teachers (26%) were reluctant to use the system due because of its potential use in evaluating teachers.

Support from Key Personnel

One factor mentioned by Oak Knoll staff concerning the acceptance of the CMI was support from key personnel in the district. Lack of support from key personnel was a source of resistance. The school staff we interviewed mentioned lack of support from a variety of sources (see Table 3): the district office (16%), principals (12%), respected teachers (4%), and the teachers' association (4%). Some principals reportedly showed little interest in the system and didn't feel its use was necessary. As one teacher said about a principal's policy toward the CMI, "It was left open as to use."

It was suggested by one principal and three pilot teachers that the district could show support for use of the CMI testing system by providing materials, for example, duplication of the CMI tests rather than having the schools or teachers absorb the costs.

Training

Training provides an additional form of support that can facilitate implementation of an innovation. Lack of training, on the other hand, may be an inhibitor to the implementation process. Teachers at schools using the CMI testing system received a workshop in testing administration and scoring procedures. Some school sites had scanning equipment (a test scanner, a computer terminal connected by modem to the district's HP3000). At these sites, students' answer sheets were run through the scanner to be scored. Many teachers did their own scanning. At other sites, students' answer sheets were sent to the district office for scanning and scoring.

While inadequate CMI training was cited as a problem by 28% of the school staff respondents (see Table 3), teachers who didn't use the scanning equipment considered their training to be satisfactory for using the CMI testing system. When respondents cited problems with training, they referred mostly to the absence of training in using the CMI for

instructional purposes, e.g., interpretation of test results for diagnosing student difficulties and prescribing appropriate instruction. Twenty-four percent 24% of the school staff recommended more training for instructional uses (see Table 5). The need for inservicing on how to read and interpret the reports was mentioned in addition to how to use teacher made tests on the system.

Regarding technical training on the CMI, while many interviewees reported it to be generally satisfactory and helpful, several people said they needed more "hands-on, experientially oriented" training. While this "hands on" experience was cited as the best part of the training, some Oak Knoll staff felt they needed more time using the equipment in a practice situation. The need for such "hands on" training, of course, varies for different individuals.

Perceptions of the technical training varied by school and by how much interaction the teachers were required to have with the scanning equipment. Some interviewees mentioned that too much information was covered in one session. One respondent rated the training as helpful but insufficient for teachers to be able to use the scanner alone. More technical training was recommended by 16% of the staff interviewed (see Table 5).

Technical Issues and Procedures

In the implementation of any new program or innovation dealing with technical equipment (such as the computers and scanners needed for the CMI), any problems related to the equipment and its operation will undoubtedly affect the attempts to use the program. As noted in Table 3, technical problems were reported as the most significant source of resistance to the CMI (39%), especially by the pilot school staff (65%) who were actually exposed to the CMI equipment.

Technical problems. Numerous problems with the CMI contributed to a negative image of its effectiveness according to a number of school staff in the Oak Knoll district. As reported in Table 6, these problems included hardware (43%), test format (35%), software (31%), test quality (29%), technical output (22%) and system compatibility (6%).

Difficulty with the scanning equipment was a major hardware problem. The equipment has been described as slow, variable in its reliability, and "oversensitive to heat." Pre-slugging did not always work and answer sheets had to be rebubbled in a number of cases. One source used a variety of procedures to scan pre-slugged answer sheets after a first attempt had failed: rebubbling the answer key, rebubbling student information, rebubbling student answers, each procedure followed by attempting to scan the answer sheets again. Additional procedures included rebooting the scanner, then reprogramming it before trying to scan the answer sheets again. A last-resort measure was standing at the scanner with one's hand on it. A FWLERD researcher observed the success of this seemingly innocuous measure after numerous attempts to can a set of answer sheets had failed.

Table 5
Recommendations for Future Use of the CMI
Indicated by Pilot and Nonpilot Respondents

	Percentage of Respondents		
	Pilot (n=26)	Nonpilot (n=23)	Total (N=49)
New, clearer test copies	15	9	12
One key person responsible for scanning on site	31	0	16
More technical training	19	13	16
Training for instructional uses	31	17	24
More administrative support in building and district	23	22	22
Other	19	35	27

Table 6
Technical Problems
Reported by Pilot and Nonpilot Respondents

	Percentage of Respondents		
	(n=26) Pilot	(n=23) Nonpilot	(N=49) Total
Hardware	73	9	43
Software	42	17	31
Technical Ouput	23	22	22
System Compatibility	8	4	6
Test Format	35	35	35
Test Quality	35	22	29
Other Problems	12	4	8

The test format was cited as a problem. One person noted that it was unlike the CTBS format, questioning whether this format actually assisted or confused students. Others complained about the graphics, the print clarity and the layout. There were also problems with the use of answer sheets for young elementary students, particularly for those in kindergarten.

School staff detected one particular software problem early in the implementation process: student answer sheets, allowing 100 test items, could only be used for one test (usually 8 to 10 items). Answer sheets were expensive. In addition, since all information on the answer sheet was required to be completed before scoring, it was time-consuming to use a different answer sheet for each test. The district staff working on the CMI implementation later solved this problem. Teachers were then able to use one answer sheet for multiple tests.

Reportedly there was variation in the quality of the tests. Certain tests did not cover the full range of skills in particular objectives, for example, eight items on measurement were not sufficient to test mastery. Other tests were reportedly too easy. For example, one teacher cited a geometry test on which all of the students in a particular class unexpectedly earned 100%. Some reading tests reportedly contained vocabulary that was too difficult for the students at that level.

Technical output was also a problem. For a number of schools, the sorting procedure was inadequate. For middle schools, the matrix and scanner answer sheets only came grouped by core class and had to be resorted by hand into subject sections. This reportedly required several hours to complete. Sorting was also a problem in elementary schools where blank student answer sheets were grouped by grade level. It was also reported that processing was very slow, resulting in very slow turn-around time. According to a few sources, some test results were never returned to the teachers. One user of the system estimated that it took approximately 25 minutes to scan answer sheets for one class of 30 students. A clerical aide at a middle school estimated that she spent two to three hours per day handling tests for the four math teachers who used the CMI. In one instance, it required two days to scan the multiple tests one middle-school teacher gave to her five math classes.

Finally, there was some concern about the CMI's compatibility with other systems. For example, teachers questioned whether computerized report cards and reading tests currently scored on non-CMI scanning equipment could be used with CMI scanning equipment.

Procedures and test administration. Many respondents reported that teachers spent a lot of time on tasks related to using the CMI: 7% of the teachers interviewed and 14% of all school respondents spent 16 or more hours a month. Preparatory tasks included copying exam questions; searching through files for exams; sorting answer sheets; bubbling answer keys and student information on answer sheets. During class, time was occupied with explaining procedures; handing out pre-slugged answer sheets to the appropriate students; passing out exams; administering the exams; and collecting answer sheets and exam sheets. After the exam, time was spent resorting answer sheets with the appropriate keys; hand scoring exams or sending/taking them to be scored; and scanning answer sheets.

Once the test results were returned from the district office, tasks included interpreting test results for grouping, planning and diagnostics; recordkeeping on student mastery; filing reports and test papers; and reteaching when appropriate. Additional time was spent making sure all students had number 2 pencils; securing enough answer sheets; and waiting for test results to return.

Some teachers who personally scanned their students' tests had problems gaining access to the CMI system at their particular schools. Without a free period or prep time, teachers reported that they had to resort to using the system before school, during lunch, or after school, yet their contractual arrangements required them to be at school only 20 minutes prior to the beginning of school and to stay only 15 minutes after school. Thus, teachers found it difficult to scan their own tests within the limits of the contractual teaching day.

Lack of time also inhibited teachers' attempts to use the system to enhance their teaching. One purported benefit was to improve teachers' self-evaluation and consequently their instruction. However, teachers responsible for scanning their students' tests spent much of their time dealing with the equipment and its frustrations. There was little time or initiative left to plan lessons around the test results.

While full sets of answer sheets could be run easily on the scanner, scoring answer sheets for just a few students was cumbersome. Each test required a separate answer key. Therefore, when several students took several different tests, multiple answer keys were required for each class. A number of teachers were hand-scoring CMI tests at the end of the school year in order to get immediate feedback on minimum proficiencies for a few students at a time.

Incentives

The benefits and motivations mentioned by respondents for using the CMI are shown in Table 7. Classroom personnel used the CMI system for testing and updating primarily because it was mandated (according to interviews with 37% of all school staff and 42% of pilot school staff). The CMI system was also used because of its potential benefits; its ease and speed in testing and updating students on the curriculum objectives; and from curiosity or interest in how the system worked. It was also said that some classroom staff used the CMI system to please or appease their principals.

Twenty-two percent of the school staff interviewed were motivated to use the CMI for its potential benefits and uses, both instructional and noninstructional. The instructional uses included information for grouping, planning, pacing, and diagnostics. Noninstructional uses were assessment of class and teacher progress for administrative uses, parent conferences and student conferences. Potential benefits served as an incentive more often for nonpilot respondents (30%) than for those in pilot schools (15%), perhaps due to the fact that use in nonpilot schools was voluntary. We found that teachers who had positive attitudes about the use of the system also perceived more current and potential uses of the system which would benefit them. Those teachers who had negative or uncertain

Table 7
Motivations and Incentives for Using the CMI
Indicated by Pilot and Nonpilot Respondents

	Percentage of Respondents		
	Pilot (n=26)	Nonpilot (n=23)	Total (N=49)
To please/appease the principal	8	13	10
Mandated	42	30	37
Curious/Interested	8	13	10
Potential Benefits	15	30	22
Easier and/or faster	19	22	20

attitudes toward the system tended to perceive fewer instructional purposes and applications for the system, and little benefit for themselves. These teachers also did not use the system as widely.

Several veteran teachers we interviewed felt they could have contributed considerably to the development of a successful program. They additionally felt that their skill and expertise were not being acknowledged at the district level, resulting in negative feelings and suspicion about the validity of the tests by some school staff (16% as shown in Table 3.) On the other hand, several teachers who reported that their expertise had been employed in developing reading tests seemed enthusiastic and positive about the CMI system, its validity and its use. This example demonstrates how positive attitudes were generated towards the CMI by soliciting teacher input.

Several respondents reported that the CMI system itself carried no rewards or incentives. Therefore, school staff with this negative attitude did not see any advantage for themselves in using the system, only additional work for those who were already overloaded. One source called the system "a new toy" for the district to play with, which was being imposed on teachers.

The perceived purposes of the system can serve as positive or negative incentives for using the CMI. Negative perceptions of the CMI's purpose were deterents to its use. A number of teachers felt the purpose of the system to be reporting and standardization, and without instructional application. This resulted in some teachers testing with the CMI without looking at the reports for instructional guidance or seeing any value in them.

Discussion

The majority of all levels of personnel interviewed had positive attitudes toward the CMI (with a relatively small percentage being outright negative), which should serve as a potential general facilitator for further implementation efforts. However, in spite of such a tendency toward a receptive overall disposition, interviewees reported a number of factors which operated as barriers to implementation. Some of the major barriers to use of the CMI by school personnel were: a perception of lack of planning by the district; lack of knowledge about the CMI; lack of both communication and consensus about its purposes, potential uses, and benefits; lack of support from key personnel at the district and school levels; lack of training, especially for instructional uses; a range of technical problems encountered with both the system hardware and software; lack of time to devote to the tasks accompanying the system's use; and lack of perceived incentives or rewards for using the system. Especially troublesome for many teachers trying to use the system were the numerous technical problems, such as operating the scanner, dealing with answer sheets, and sorting reports.

School staff suggested various factors, on the other hand, which might facilitate the CMI implementation and use by teachers: using the skill and expertise of teachers in the planning process and in test

development; knowledge and understanding of CMI purposes, benefits and potential uses; support for implementation from principals and the district office; the technical support provided by the district and by site technical personnel; and the provision of training to use the CMI instructionally. The presence or absence of a particular factor may operate either as a barrier or facilitator to the implementation. The key seems to be to capitalize on the "state" of each factor that is facilitative rather than the "state" which inhibits the CMI's use.

Putting the Findings in Perspective

It is important to point out that effecting an innovation takes considerable time. Our study encompassed only the first half-year's effort at a pilot implementation: its problems and successes need to be considered in that light. Although OKESD began its CMI implementation several months later than originally planned, such a late start is probably not unusual given the technical nature of the CMI hardware and software and the problems that occurred as a function of the complex technology. In another study of the implementation of computerized management systems in school districts, it was found that it took the districts five to eight years to evolve their programs to a relatively advanced state (Williams & Bank, 1984).

In view of the relatively short time span we studied, it is important to acknowledge the successes of the CMI pilot effort. First of all, it was intended to be a pilot "test": any pilot test is going to surface problems and "bugs". To the extent that the district "surfaced" all the technical "bugs" that it did and solved many of them (including many of those we have listed in our report), the pilot test can be considered a success, albeit perhaps a qualified one. Second, the district learned a good deal about the technical nature of the system and about its use in selected schools. The knowledge the district gained about the factors which encouraged implementation, as well as those which hindered use of the CMI, provides information that can be used constructively in planning and coordinating the expansion of the CMI into additional curricular areas (such as reading and language) and more school sites.

Theoretical Perspectives on Change

It seems appropriate here to discuss our findings within the readily applicable theoretical framework outlined by Roberts (1978, as discussed by Brown, 1984). A number of factors derived from the interviews with both pilot and nonpilot school personnel, as well as district staff, were determined to be facilitators or barriers to the implementation of the CMI during its pilot phase in the Oak Knoll School District. The notions of barriers and facilitators are key concepts for OKESD, as for any organization attempting an innovation, to take account of in the process of implementing the CMI system throughout the district.

Roberts delineated critical potential barriers and facilitators relevant to the introduction of computers into schools for administrative uses, a framework which seems equally appropriate to consider in the present context of introducing computers into the district and schools for

instructional management purposes.

Roberts' potential barriers. Roberts' first barrier is the complexity of the computer itself in terms of both hardware and software, which makes its acceptance problematic. This was evidenced in the variety and magnitude of the technical problems encountered in Oak Knoll's CMI implementation effort.

Roberts' second proposed barrier entails the resources required, including ample time and effort needed by personnel to use the computer as intended. In Oak Knoll, this barrier was evidenced by lack of time and access to equipment by teachers; in some cases, lack of adequate personnel to perform the technical functions; and lack of material resources such as test copies and answer sheets.

Third, Roberts points out the demand for understanding as a barrier in that the "mysterious" nature of the computer to many staff members inhibits their use of it. This barrier can translate to the inability of some Oak Knoll staff to operate the equipment effectively; their descriptions of the scanner as being "sensitive" or requiring the "magic touch" to make it work; their hesitancy about even getting their "hands on" the computer; and their reported need for more training.

The fourth barrier suggested by Roberts--the need for role change or alterations in ways personnel perform administrative tasks--operated as a barrier in some cases where schools did not clearly delineate such new roles or struggled with a need for them (as in the case of the school which eventually turned to designating a specific staff member to perform the necessary technical functions of the CMI system).

Roberts' change facilitators. Roberts also outlined a number of change facilitators that apply directly to the Oak Knoll CMI implementation effort. Some facilitators are classified as strategic principles: (1) planning oriented toward the computer user and allowing sufficient preparation time; (2) support, indicating high-level administrative endorsement and commitment of resources; and (3) training that is adequate and that allows for individual differences among users.

Other facilitators are classified by Roberts as process factors: (1) participation that includes shared decisionmaking and involvement of all users; (2) communication that includes commonly understood terminology and strategies for reducing potential conflicts; and (3) motivation, including opportunities for professional growth and recognition of accomplishments.

We have directly discussed all of these barriers and facilitating factors under related headings and we have pointed out that the apparent lack of the change facilitators has, in turn, posed barriers in various ways to the district's attempts at implementing the CMI, such as those barriers above posed by Roberts.

Significance

Many school districts are focusing on outcome-based education, mastery of basic skills by students, standardized curricular objectives, alignment

of testing to curriculum, and technological innovations as efforts at school improvement. Thus, interest in computerized instructional management systems will increase. Beyond the usefulness of this study to the district involved, other districts planning or beginning to implement such a system can benefit from Oak Knoll's experience, its problems, and its successes. Knowledge of the factors that encouraged and discouraged successful implementation of the CMI can serve as a guide to their own efforts to use successfully a computerized instructional management system.

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APPENDIX

STUDY INTERVIEW SCHEDULE

Personal History

1. Tell me about your history in the district.

Uses of the CMI

2. (Purpose/Communications)

Tell me what you know about the district's computerized instructional management system.

How and when did you learn about the system?

What was your initial reaction to the CMI? How has that changed?

3. (Instruction)

How has instruction been affected by the CMI (or updating)?

(Each content area separately: math, reading, language arts)

(grouping, pacing, diagnostics, planning, etc.)

4. (Curriculum/Content)

How has the content of instruction been affected (in the 3 updating areas)?

(Non-users: by the updating of the terminal objectives)

(In math - in reading - in language arts?)

Which text do you use?

Do you use the text differently now?

Does the CMI (or updating) affect the scope and sequence of the curriculum?

5. (Testing)

Do you do more or less testing with the CMI (or updating) system?

How often do you test now?

How did you test before the CMI?

What information can you obtain from the CMI or updating system?

How do you use the test results?

How useful are the test results for your teaching?

CMI users: Is testing easier or harder using CMI?

6. (Updating Activities)

Do you update student objectives?

What kind of system do you presently use to update student progress on the district objectives?

in math, reading, language arts

How much time do you spend on activities or tasks related to the system?

daily, weekly, monthly

How do you spend that time?

Do you spend more or less time than before?

What did you use before your present system?

7. (School/Work Organization)

Do you organize your classes differently as a result of the CMI and updating?

Has there been any change in the way you work with other staff members in your school?

for coordination, planning, grouping

in the division of labor

8. (Evaluation)

What do you like and dislike about the system?

9. (Usage: Potential)

What are the potential uses of CMI?

for teaching

for teachers' relations with parents/or students

for administration

for the district

Technical Uses of the CMI

1. How many terminals or scanners for use with the CMI system are located at your site?

   Where is the equipment located?

   When can they be used?

   Who is in charge of the equipment?

   Who are the primary users? (name them and their job titles)

2. Have you experienced any technical problems with the system?

   Has there been any "down time?"

3. Is the information from the computer output presented in a clear and usable form? (matrices, tests, CMI reports)

   Understandable to teachers?
   parents?
   students?

Training

1. Have you received any CMI training?

   What did it consist of?

   Who gave the training and how long was it?

   What was effective and what wasn't?

   Is there ongoing training and support?
   If yes: tell me more about it.

2. What means are available to you to voice opinions regarding the system and its performance?

CODING MATRIX revised 6/12/85

Personal History

1 - 2 Personal identification number
10 George
20 Hubbard
30 Ocala
40 Meyer
50 Sheppard
60 Shields
70 Slonaker
80 Pala
90 District
00 Other

3 - 4 Position/Grade
T Teacher
R Resource Teacher
P Principal
A Aide
C Clerical
E Comp Ed
V Evaluation
U Curriculum

Highest Grade
0 Non-teacher
K - 8
9 Unknown

5 - 6 Years in district
99 Unknown

7 Pilot status of school in which employed
P Pilot
N Nonpilot

8 Level of school in which employed
E Elementary
M Middle

9 Card #1 or 2

10-11 Blank

Purpose/Communications (statement of purpose, use of system)

12 M Monitoring student progress - updating

13 C Curriculum - focus on content and instruction/objectives

14 T Testing - CTBS and assessment of mastery

15 E Evaluation of teachers, teacher performance

16 S Increase Test Scores

17 D Standardization of district measures of mastery

18-19 Blank

Curriculum/Content

20 Content Focus: Choose the one that applies.
- O On objectives (objective-driven instruction)
- T On text or other
- X Unknown, not mentioned
- M On minimum proficiencies

21 Change in textbook use
- Y Yes, there has been a change
- N No, there hasn't been a change
- X Not mentioned, unknown

22 Change in scope of curriculum
- M More extensive
- L Less breadth
- N No change
- U Coder uncertain, protocol unclear, respondent undecided
- X Not mentioned, unknown

23-25 Blank

Testing

26 Change in amount of testing with CMI/updating
- M More testing
- L Less testing
- N No change in amount of testing
- U Uncertain, unclear, undecided
- X Not mentioned, unknown

27 Difficulty of testing with CMI/updating
- M More difficult to test
- L Less difficult to test
- N No change in testing
- U Uncertain, unclear, undecided
- X Not mentioned, unknown
- C Conditional

28 Type of tests used
- C CMI
- U Unit tests from texts
- O Teacher's own tests
- X Unknown
- F Unit tests with teacher's own tests
- G CMI with unit tests
- H CMI with teacher's own tests
- J CMI with unit and own tests

29 Whether student performance on the CTBS objectives affects grading
- Y Yes
- N No
- X Unknown, uncertain, unclear

Instruction applications - test results and/or matrix: Non-CMI

30 - 37		How test information is used: code each of the following that apply; put in X when it doesn't.
30	G	Grouping/Placement
31	L	Planning
32	D	Diagnostics for individuals
33	P	Pacing
34	M	Mastery assessment
35	C	Minimum competency for promotion/graduation

Other applications of test results and/or matrix: Non-CMI

36	Z	Parent conferences
37	S	Student conferences
38	F	Family tutoring
39	E	Evaluation
40		Blank

Instruction

41 - 51		How CMI information is used: code each of the following that applies; put in X when it doesn't.
41	G	Grouping
42	L	Planning
43	D	Diagnostics for individuals
44	P	Pacing
45	M	Mastery assessment
46	C	Minimum proficiency/competency
47	Z	Parent conferences
48	S	Student conferences
49	F	Family tutoring
50	E	Evaluation
51 - 52		Blank

Updating

53 Updating other areas
- C CMI
- M Matrix
- N Nothing
- Z Subject area not applicable
- X Unknown

54 Present system used by person for updating math only
- C CMI
- M Matrix
- N Nothing
- Z Subject area not applicable
- X Unknown

55 - 56 Blank

Time Use

57 Time spent on CMI, updating, etc. (in hours per month: multiply daily by 20, weekly by 4)
- 1 0 - 5 hours/month
- 2 6 - 10
- 3 11 - 15
- 4 16+
- 9 Unknown

58 Change in time use
- M More
- L Less
- N No change
- U Uncertain (interviewee)
- X Unknown (to coder)
- C Conditional

59 - 64 Tasks

59 P Planning

60 S Scanning

61 R Recordkeeping and clerical

62 A Scoring

63 M Meetings

64 O Other

65 Blank

Card 2

Potential Usage

12 - 24		Possible uses for the system: code each of the following that apply; put in X when it doesn't.
12	U	Updating/Placement
13	G	Grouping
14	L	Lesson Planning
15	D	Diagnostics for individuals
16	P	Pacing
17	M	Mastery Assessment
18	C	Minimum proficiency/competency
19	Z	Parent conferences
20	S	Student conferences
21	F	Family tutoring
22	E	Teacher evaluation
23	T	Testing
24	O	Other
25 - 26		Blank

Technical

27 Primary users of hardware

- T Teacher
- P Principal
- R Resource teachers
- C Clericals
- O Other
- A Aide
- X Unknown
- N Nonpilot

Technical (continued)

28 Location of equipment
- T Teacher workroom
- L Library
- O Office
- P Principal's office
- Z Other
- X Unknown
- N Nonpilot

29 - 34 Technical Problems: code each that applies; put X when it doesn't.

29 H Hardware

30 S Software

31 O Technical Output (e.g inaccuracies, missing info)

32 C System compatibility (incorporating other systems into CMI)

33 F Test format (including legibility)

34 Q Test quality (too hard, too easy, too short, proper alignment)

35 U Problems: Source unknown

36 - 37 Blank

Report Use: Is the output OK? Use the following codes:

38 - 41
- H Helpful
- S Satisfactory
- N Some problems
- M Many problems
- X Unknown, no comment

38 For teachers: format

39 For teachers: content - information

40 For parents

41 For students

42 - 43 Blank

Training

44 Was training/inservice received?
- Y Yes
- N No
- X Unknown

45 Was the training effective?
- H Helpful
- S Satisfactory
- N Negative aspects
- X Unknown

46 Is there ongoing support?
- H Ongoing support: Helpful and of high quality
- S Ongoing support: Satisfactory
- N Not received or negative aspects
- X Unknown

47 - 48 Blank

Administrative Issues

49 Was respondent personally involved in the selection and development process of the CMI?
- Y Yes
- N No
- U Unknown, uncertain

50 What is respondent's attitude towards the CMI/updating system?
- P Positive
- N Negative
- U Uncertain, unclear, undecided
- X Not mentioned, unknown

51 - 52 Blank

Sources of Resistance

53 - 67 Put P as a personal concern of the respondent,
Y as a concern of others,
N in categories not reported.

53 Too much and/or too rapid change

54 Doubt about long term commitment to program

55 Too late in year for implementation

56 Technical problems leading to frustration/avoidance

Lack of support from:

57 respected teachers

58 teachers association

59 principal

60 district

61 Processing/reporting too slow

62 Problems with report or data (wrong names, misplaced info)

63 Fear of evaluation

64 Inadequate training

65 Too much paperwork

66 Too much class time

67 A lot/too much time

68 Coercion - mandated by district

69 Lack of confidence in tests

70 Teachers not asked for input

71 Coordination and supply of materials

72 Other

School Organization (Card 3) p.9

12 Collaboration with colleagues
- M More
- L Less
- N No Change
- U Uncertain
- X Unknown

13 - 21 For these numbers use the appropriate letter including:
- N No change
- X Unknown

Changes in meetings

13 A Yes, change in amount

14 T Yes, change in type

15 F Yes, change in frequency

Change in school structure

16 S New structure, e.g. lab

17 G Grade level collaboration

18 I Inter-grade level collaboration

19 D More departmentalization

20 C More self-contained classes

21 O Other

22 Class schedule changes within the school
- Y Yes, there have been changes
- N No, there haven't been any changes
- X Unknown

23 Staffing changes
- R Yes, changes in staffing responsibilities
- A Yes, adding staff
- D Yes, decreasing staff
- N No
- X Unknown

24 Changes in teacher relations with students
- A Yes, positive
- B Yes, negative
- N No change
- X Unknown

25 Changes in teacher relations with parents
- A Yes, positive
- B Yes, negative
- N No change
- X Unknown

CODING MATRIX

(Card 3, continued)

26 - 27		Blank

Benefits

28 - 37		Possible benefits to using the system: code each of the following that apply; put in X when it doesn't.
28	T	Easier and/or faster to test
29	U	Easier to update
30	D	Standardization of district measures
31	A	Administrative needs
32	I	Instruction (planning, diagnostics, pacing, grouping)
33	S	Students
34	P	Parents
35	R	(makes teachers aware of) specific requirements and district expectations
36	Y	Accuracy of assessment/objectives measures
37	F	Improving instruction by focusing on objectives or proficiencies
38 - 39		Blank

Motivation/Incentives

40 - 44		Why do teachers use updating/CMI?
40	P	To please/appease the principal
41	M	Mandated
42	C	Curious/interested
43	B	Potential benefits
44	T	Easier and/or faster

45 - 46 Blank

Procedural Aspects

47 How much has the person used CMI?
- L A little
- S Some
- M A lot, much
- N Not at all
- X Unknown

48 How has the person used CMI?
- L Uses tests without scanning
- S Uses tests with someone else scanning
- M Uses test and scans himself
- N Not at all
- X Unknown

50 - 51 Blank

Recommendations for future use

52 C New, clearer test copies

53 K One key person responsible for scanning on site

54 T More technical training

55 I Training for instructional uses

56 A More administrative support in building and district

57 O Other